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| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
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| 09/899,872 | 07/05/2001 | Enrico Griseri | CISCP690 | 6618 |

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| EXAMINER | |
|---|---|
| CUNNINGHAM, STEPHEN C | |

| ART UNIT | PAPER NUMBER |
|---|---|
| 3663 | |

DATE MAILED: 06/11/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

| Office Action Summary | Application No. | Applicant(s) |
|---|---|---|
| | 09/899,872 | GRISERI ET AL. |
| | Examiner | Art Unit |
| | Stephen C. Cunningham | 3663 |

*-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address*

**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

1)☒ Responsive to communication(s) filed on *05 March 2004*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

4)☒ Claim(s) *2,4,6,7,9-12,19,21,22,24,26 and 27* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *2,4,6,7,9-12,19,21,22,24,26 and 27* is/are rejected.

7)☒ Claim(s) *11* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

**Application Papers**

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *10 June 2003* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

**Priority under 35 U.S.C. § 119**

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

**Attachment(s)**

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

## DETAILED ACTION

### *Claim Objections*

Claims 11 are objected to under 37 CFR 1.75(c), as being of improper dependent form for failing to further limit the subject matter of a previous claim. Applicant is required to cancel the claim(s), or amend the claim(s) to place the claim(s) in proper dependent form, or rewrite the claim(s) in independent form.

The fiber claimed in claim 11 has previously been claimed in claim 4, therefore 'said fiber' does not add any new limitations.

Regarding claims 10 and 11, Applicant claims

### *Claim Rejections - 35 USC § 102*

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

Claim 2 is rejected under 35 U.S.C. 102(e) as being anticipated by Ackerman et al. (`963) (hereafter "Ackerman").

Regarding claim 2, Ackerman teaches an optical communication system, which includes an apparatus for amplifying an optical signal, comprising: (1) a fiber (see column 1, line 23); (2) an optical pump energy source disposed to inject optical pump energy into said fiber in a co-propagating direction relative to a transmission direction of

an optical signal in said fiber to cause Raman amplification of said signal in accordance with a gain level (see column 3, line 65 to column 4, line 4); and (3) wherein said gain level is greater than 4 dB (see column 5, lines 47-48; column 7, line 7). While Ackerman does not explicitly teach that for a selected signal to noise ratio there is a greater four-wave mixing product than would be achieved using only a counter-propagating optical pump energy. Ackerman inherently teaches that when given a signal to noise ratio, there is a greater four-wave-mixing product suppression level than would be achieved using only a counter-propagating optical pump energy source to obtain said gain level. The inherence stems from the fact that the only requirements for this to occur is that there be a co-propagating Raman pump imparting a gain of greater than 4 dB to the optical signals amplified therein. The claim requires (and in fact the Application, considered as a whole teaches) that the only things necessary to achieve the claimed result is a fiber, a co-propagating pump source, which imparts a gain of greater than 4dB. Thus, the "beneficial" (see Paper No. 4 at 22) four wave mixing product suppression is latent, ergo inherent in the apparatus of Ackerman, as Ackerman discloses all of the components and values claimed. Ackerman does not explicitly disclose a gain level responsive to minimum tolerable four-wave mixing product suppression level and a desired signal to noise ratio. However, it is inherent in any functioning optical amplifier that a gain level is set responsive to minimum tolerable four-wave mixing product suppression level and a desired signal to noise ratio. If either a four-wave mixing product suppression level or a signal to noise ratio (SNR) drop below a minimum tolerable level the amplifier fails to function.

Claims 2, 4, 7, 9, 10, 12, 19, 22, 24, and 27 are rejected under 35 U.S.C. 102(e) as being anticipated by Akasaka et al. (09/899,872) (Hereafter "Akasaka").

Regarding claim 2, Akasaka teaches an optical communication system, which includes an apparatus for amplifying an optical signal, comprising: (1) a fiber (see column 5, line 63); (2) an optical pump energy source disposed to inject optical pump energy into said fiber in a co-propagating direction relative to a transmission direction of an optical signal in said fiber to cause Raman amplification of said signal in accordance with a gain level (see figures 2, 3, 26, 30, 32, 35, and 36); and (3) wherein said gain level is greater than 4 dB (see figures 54 A through 59, 61, 63, 66, 69, 71, and 73). While Akasaka does not explicitly teach that for a selected signal to noise ratio there is a greater four-wave mixing product suppression than would be achieved using only a counter-propagating optical pumping energy. Akasaka inherently teaches that when given a signal to noise ratio, there is a greater four-wave-mixing product suppression level than would be achieved using only a counter-propagating optical pump energy source to obtain said gain level. The inherence stems from the fact that the only requirements for this to occur is that there be a co-propagating Raman pump imparting a gain of greater than 4 dB to the optical signals amplified therein. The claim requires (and in fact the Application, considered as a whole teaches) that the only things necessary to achieve the claimed result is a fiber, a co-propagating pump source, which imparts a gain of greater than 4dB. Thus, the "beneficial" (see Paper No. 4 at 22) four-wave mixing product suppression is latent, ergo inherent in the apparatus of Akasaka,

as Akasaka discloses all of the components and values claimed. Akasaka does not explicitly disclose a gain level responsive to minimum tolerable four-wave mixing product suppression level and a desired signal to noise ratio. However, it is inherent in any functioning optical amplifier that a gain level is set responsive to minimum tolerable four-wave mixing product suppression level and a desired signal to noise ratio. If either a four-wave mixing product suppression level or a signal to noise ratio (SNR) drop below a minimum tolerable level the amplifier fails to function.

Regarding claims 4, 19, and 24, see rejection of claim 2 that is incorporated in full by reference. Akasaka further teaches (4) an optical pump energy source disposed to inject optical pump energy into said fiber in a counter-propagating direction relative to a transmission direction of an optical signal in said fiber to cause Raman amplification of said signal in accordance with a gain level (See figure 15). The Akasaka reference teaches an amplifier wherein the aggregate gain is at least 10 dB. The pump sources provide overlapping gain bands with regions where the co-propagating pump source provides greater than or equal to 4 dB.

Regarding claim 7, it is inherent in the disclosure of Akasaka that the second gain level is set responsive to the first gain level and the total gain level. Figure 13B, for example, shows pumps of adjacent wavelengths having overlapping gain bands. The overlapping gain bands form an aggregate gain function which is designed to be substantially flat.

Regarding claim 9, it is inherent in the disclosure of Akasaka that the power level of the first optical pump energy source is set responsive to the first gain level. Akasaka

adjusts the power level of the first optical pump energy source responsive the first gain level. Claim 4, from which claim 9 depends, states "a **first optical pump energy source disposed to inject optical pump energy** into a fiber in a co-propagating direction relative to a transmission direction of said optical signal **to cause Raman amplification of said signal in accordance with a first gain level.**" It is understood by Examiner that the 'first gain level' is by definition the gain component produced by the first pump source.

Regarding claim 10, it is inherent in the disclosure of Akasaka that the power level of the second optical pump energy source is set responsive to the second gain level. Akasaka adjusts the power level of the second optical pump energy source responsive the second gain level. Claim 4, from which claim 10 depends, states "**a second optical pump energy source disposed to inject optical pump energy** into a fiber in a counter-propagating direction relative to a transmission direction of said optical signal **to cause Raman amplification of said signal in accordance with a second gain level.**" It is understood by Examiner that the 'second gain level' is by definition the gain component produced by the second pump source.

Regarding claims 12, 22 and 27, Akasaka teaches an apparatus further comprising an erbium-doped fiber amplifier in cascade with said fiber. See, figures 9 and 10.

***Claim Rejections - 35 USC § 103***

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 4, 6, 7, 9-12, 19, 21, 22, 24, 26, and 27 are rejected under 35 U.S.C. 103(a) as being unpatentable over Cornwell, Jr. et al. (`383) (hereafter "Cornwell") in view of Ackerman.

Regarding claims 4, 19, and 24, Cornwell teaches an optical amplifier in a fiber-optic communications system, comprising: (1) a first optical pump energy source (Fig. 5, first set of sources (from left to right), 12, right-hand source) disposed to inject optical pump energy into a fiber (Fig. 5, 36) in a co-propagating direction relative to a transmission direction of said optical signal to cause Raman amplification of said signal in accordance with a first gain level (the first gain level is inherent, as the first optical pump energy source will impart Raman gain to the signal, as it is designed to impart said Raman gain and must therefore be above the SRS threshold for the fiber); (2) a second optical pump energy source (Fig. 5, second set of sources (from left to right), 12, left-hand source) disposed to inject optical pump energy into said fiber in a counter--propagating direction relative to said transmission direction of said optical signal to cause Raman amplification of said signal in accordance with a second gain level (inherent for the same reason that the first gain level was inherent), and wherein said optical signal experiences a total gain level including a first gain and a second gain (this is also inherent because of the additive nature of net gain). Cornwell does not teach that

the first gain level is greater than 4 dB. Ackerman teaches a first Raman pumping source that pumps a fiber so as to impart Raman gain on the optical signals that is greater than 4 dB. It would have been obvious to modify the Cornwell amplifier to include a first pumping source that yields a gain of greater than 4 dB because such is well known in the Raman amplifier art and presents an amplification system with numerous benefits, as described in column 3, lines 40-49 of the Ackerman patent.

Additionally, Cornwell does not teach that when given a signal to noise ratio, there is a greater four-wave-mixing (FWM) product suppression level than would be achieved using only said second optical pumping energy to obtain said total gain level. Ackerman inherently teaches that this is the case. The discussion of claim 2, above is hereby incorporated by reference to support the determination that Ackerman inherently exhibits such phenomena.

Neither Ackerman nor Cornwell explicitly disclose a gain level responsive to minimum tolerable four-wave mixing product suppression level and a desired signal to noise ratio. However, it is inherent in any functioning optical amplifier that a gain level is set responsive to minimum tolerable four-wave mixing product suppression level and a desired signal to noise ratio. If either a four-wave mixing product suppression level or a signal to noise ratio (SNR) drop below a minimum tolerable level the signal degrades such that the amplifier fails to function.

It would have been obvious to modify the Cornwell reference to utilize the co-propagating Raman pumping system of Ackerman because of the numerous benefits to be obtained by such a modification such a reduced pump-signal cross-talk, which would

have the inherent effect of yielding a beneficial FWM product (See Ackerman at column 3, lines 40-49).

Regarding claims 11, Cornwell teaches a Raman amplifier that comprises a fiber (Fig. 5, 36).

Regarding claims 12, 22, and 27, Cornwell teaches an erbium-doped amplifier in cascade with the fiber. See particularly column 11, lines 22 to 32.

Claims 7, 9 and 10 are rejected under 35 U.S.C. 103(a) as being unpatentable over Cornwell in view of Ackerman and Aoki (cited to show inherency).

Regarding claim 7, Cornwell does not teach that the second gain level is set responsive to said first gain level. This is an obvious modification to the Cornwell amplifier. First of all, it is well known that by increasing pump power the gain of the amplifier can be increased, which to a point, will increase the SNR of the amplifier and the amplifier gain. See generally, Aoki at 1227-28. It would have been obvious to modify the Cornwell amplifier to determine a total desired gain value, and set a second gain level in accordance with the first gain level because as is well known in the art, the total amplifier gain is a function of input pump power (Id.) and that by increasing the incident pump power (regardless of forward or backwards pumping) one would increase the gain of the amplifier to a desired gain, as would have been appreciated by one of ordinary skill in the art at the time of the invention by applicant.

Regarding claim 9, Cornwell inherently teaches that the first optical pump energy source is set in accordance with a first gain level. The purpose of using a Raman pump is to impart Raman gain on the optical signal, and by pumping above the SRS

threshold; such gain is imparted to the optical signal. Cornwell inherently shows that the first pumping energy is set in accordance with a first gain because the first pump must be pumping above the SRS threshold (as it is intended to be a Raman amplifier).

Aoki illustrates the effects of forward pumping at various Raman pump powers to obtain a Raman gain, which shows that by pumping at a given pump level, the signal is amplified to first Raman gain level. See Fig. 4 of the Aoki article, at page 1227.

Regarding claim 10, see the discussion of claim 9.

Claims 6, 21, and 26 are rejected under 35 U.S.C. 103(a) as being unpatentable over either Akasaka in view of, or alternatively Cornwell in view of Ackerman and further in view of Lewis et al (*Gain saturation in silica-fibre Raman amplifier*) (hereafter "Lewis").

None of Akasaka, Cornwell, or Ackerman teach an apparatus wherein the power level is also set responsive to a maximum tolerable saturation level.

Lewis teaches a level where the noise figure deteriorates SNR as the amplifier gain is decreased by saturation. It would have been obvious to set amplifier gain in response to the level as a maximum tolerable saturation level in order to prevent a degradation in signal to noise ratio.

***Response to Arguments***

Applicant's arguments, see page 7, line 25, filed March 3, 2004, with respect to claims 6, 21, and 26 have been fully considered and are persuasive. The rejections of claims 6, 21, and 26 have been withdrawn and replaced with appropriate rejections.

The Vasilyev reference has been with drawn from the instant claims as unnecessary, or in the case of claims 6, 21, and 26 inappropriate. However, Examiner considers the disclosure of a range of pumping values to still be applicable to the instant disclosure. It is recognized that in order to apply the teaching of Vasilyev to the instant invention would require experimentation. It is believed that choosing ranges of pumping values based on maps of the four-wave mixing and the signal to noise ratio in a Raman amplifier would not constitute an undue burden nor provide for any unexpected improvements.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Stephen C. Cunningham whose telephone number is 703-605-4275. The examiner can normally be reached on Monday - Friday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Thomas Tarcza can be reached on 703-306-4171. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

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